The Timing and Returns of Mergers and Acquisitions in Oligopolistic Industries

Dirk Hackbarth\textsuperscript{1} Jianjun Miao\textsuperscript{2}

\textsuperscript{1}Department of Finance
Washington University in St. Louis

\textsuperscript{2}Department of Economics
Boston University

\textsuperscript{2}Department of Finance
HKUST
How do industry structure and product market competition affect the timing, terms and returns of mergers and acquisitions?

This question is not deeply understood theoretically

- IO literature focuses largely on welfare implications, but not timing, terms, and returns
- Corporate finance literature typically does not focus on product market competition
Empirical studies

- Mergers occur in waves
- More mergers in industries that are more exposed to industry shocks
- Abnormal returns are positively related to industry concentration
- Mixed evidence of anticompetitive effect
- McAfee and Williams (1988) argue that event study may not identify this effect
What we do

- Embed a real options model of M&A in an (asymmetric) dynamic industry equilibrium framework
- Characterize the timing, terms, and returns of mergers in closed-form solutions
- Analyze the interaction between bidder competition and industry competition and their effects on M&A
Related literature


- **IO**: Salant, Switzer, and Reynolds (QJE, 1983), Perry and Porter (AER, 1985), Farrel and Sharpiro (AER, 1990)
Main model ingredients

- Real options approach
  - Irreversible decision under uncertainty
  - Making a merger decision is analogous to exercising an exchange option

- Industry equilibrium framework
  - Payoffs are endogenously determined
  - (Horizontal) Mergers create value by enhancing market power and reducing production cost
  - Bidder competition and product market competition
Setup

- Time is continuous and continues forever
- An industry with $N$ heterogeneous firms producing homogeneous output
- Each firm $i$ owns capital $k_i$ and plays Cournot-Nash strategies
- Capital does not depreciate and has fixed supply

$$\sum_{i=1}^{N} k_i = K.$$ 

- Production cost for output $q$ and capital $\kappa$

$$C(q, \kappa) = \frac{q^2}{2\kappa}.$$ 

- Merged firm combines capital of the two merging partners
Industry demand

\[ P(t) = a Y(t) - b Q(t), \]

Demand shocks

\[ dY(t) = \mu Y(t)dt + \sigma Y(t) dW(t), \quad Y(0) = y_0, \]

Management acts in the best interest of shareholders

Shareholders are risk neutral and discount future cash flows at rate \( r \)

If firm \( i \) engages in a merger, it pays a lump-sum cost \( X_i \)
The strategy \( \{ (q_1^*(t), \ldots, q_N^*(t)) : t \geq 0 \} \) constitutes an industry (Markov perfect Nash) equilibrium if, given information available at date \( t \), \( q_j^*(t) \) is optimal for firm \( j = 1, \ldots, N \), when it takes other firms’ strategies \( q_i^*(t) \) for all \( i \neq j \) as given.

Focus on the equilibrium where firms play static Cournot-Nash equilibrium strategies at each time.
The strategy

$$q_i^*(t) = \frac{\theta_i}{1 + B} \frac{aY(t)}{b},$$

constitutes a Cournot–Nash industry equilibrium at time \( t \) for
firms \( i = 1, \ldots, N \), where

$$\theta_i = \frac{b}{b + k_i^{-1}} \quad \text{and} \quad B = \sum_{i=1}^{N} \theta_i$$

In this equilibrium, the industry output and price at time \( t \) are
respectively given by

$$Q^*(t) = \frac{B}{1 + B} \frac{aY(t)}{b} \quad \text{and} \quad P^*(t) = \frac{aY(t)}{1 + B}$$
Effects of a merger

Suppose firms 1 and 2 merge at date 0.
The merged firm $M$ has capital $k_m = k_1 + k_2$ and produces output $q_M(t)$ satisfying

$$\max \{q_1^*(t), q_2^*(t)\} < q_M(t) < q_1^*(t) + q_2^*(t), \quad (1)$$

Merger causes industry output to fall and price to rise
Price and quantity effects may not generate profit gains
Perry and Porter (1985): $n$ identical large firms and $m$ identical small firms

Each large firm owns an amount $k$ of capital and incurs merger costs $X_l$ if it engages in a merger

Each small firm owns an amount $k/2$ of capital and incurs merger costs $X_s$ if it engages in a merger

Use the supply condition $m = 2Kk^{-1} - 2n$ to substitute out $m$
Firm value without a merger

The equilibrium value of the type $f = s, l$ firm is given by

$$V_f (y; n) = \frac{\Pi_f (n) y^2}{r - 2 (\mu + \sigma^2/2)},$$

where

$$\Pi_s (n) = \frac{a^2 (b + k^{-1})^3}{\Delta (n)^2},$$

$$\Pi_l (n) = \frac{a^2 (b + 2k^{-1})^2 (b + k^{-1}/2)}{\Delta (n)^2},$$

$$\Delta (n) \equiv \left(b + k^{-1}\right) \left(b + 2 (Kb + 1) k^{-1}\right) - b^2 n > 0. \quad (2)$$
After a symmetric merger, the industry consists of \( n + 1 \) large firms and \( m - 2 \) small firms.

Merger benefit:

\[
V_l(y; n+1) - 2V_s(y; n) = \frac{[\Pi_l(n+1) - 2\Pi_s(n)]y^2}{r - 2(\mu + \sigma^2/2)}.
\]

To have takeover incentives, the term \( \Pi_l(n+1) - 2\Pi_s(n) \) must be positive.
Asymmetric merger of a large and a small firm

- After an asymmetric merger, there are $n - 1$ large firms, $m - 1$ small firms, and a huge merged firm.
- The equilibrium firm value is given by

$$V^a_f (y; n - 1) = \frac{\Pi^a_f (n-1) y^2}{r - 2(\mu + \sigma^2 / 2)}, \text{ for } f = s, l, M$$

- To have an incentive to merge, we must have

$$V^a_M (y; n - 1) - V_s (y; n) - V_l (y; n) > 0$$

Dirk Hackbarth, Jianjun Miao
The Timing and Returns of Mergers and Acquisitions in Oligopolistic Industries
Assumptions

1. Suppose $\Pi_M^a(n-1) - \Pi_S(n) - \Pi_L(n) > 0$ and $\Pi_L(n+1) - 2\Pi_S(n) < 0$ so that there is an incentive to merge between a large firm and a small firm, but no incentive to merge between two small firms.

2. Suppose $\Pi_L(n+1) - 2\Pi_S(n) > 0$ and $\Pi_M^a(n-1) - \Pi_S(n) - \Pi_L(n) > 0$ so that there is an incentive to merge between a large and a small firm and between two small firms.
Figure 1. Profit differentials in symmetric and asymmetric mergers.

This figure depicts the profit differentials $\Pi_l(n+1) - 2\Pi_s(n)$ and $\Pi^a_M(n-1) - \Pi_s(n) - \Pi_l(n)$ as functions of the price sensitivity parameter $b$ and the number of large firms $n$ when $a = 100$, $K = 1$, and $k = 0.2$. 
Solution Method: Backward Induction

Merger timing ($\tau$)

Before merger

Cournot game

After merger

Industry structure changes

Cournot game

Optimize over $\tau$
Consider an asymmetric merger of a large firm and a small firm (Assumption 1).

Similar to a friendly merger.

Each firm submits ownership share of the merged firm, and then determines merger timing independently.

In equilibrium, they agree with the merger timing.

Alternatively, firms first choose timing to maximize total surplus, and then determine how to share surplus.
Determination of equilibrium

• Industry’s demand shock: $Y(t)$ is the model’s state variable
Equilibrium merger threshold

\[ y^* = \sqrt{\frac{\beta (X_S + X_I)}{\beta - 2} \frac{r - 2 (\mu + \sigma^2/2)}{\prod_M^a (n - 1) - \prod_I (n) - \prod_S (n)}}. \]

Equilibrium ownership share

\[ \xi^*_I = \frac{X_I}{X_S + X_I} + \frac{\prod_I (n) X_S - \prod_S (n) X_I}{(X_S + X_I) \prod_M^a (n - 1)}. \]
Merger occurs in a rising product market (Maksimovic and Phillips (2001) and Mitchell and Mulherin (1996))

Option value of waiting

\[
V^a_M (y^*, n - 1) - V_I (y^*; n) - V_S (y^*; n) = \frac{\beta (X_s + X_I)}{\beta - 2} > X_s + X_I.
\]

\( y^* \) decreases with \( a \) and \( n \)

- More mergers in industries that more exposed to shocks (Mitchell and Mulherin (1996))
- Product market competition delays mergers
Cumulative merger returns

Returns to merging firms $f = s, l$

\[
R_{f,M}(Y(t), n) = \frac{E_f(Y(t); n) - V_f(Y(t); n)}{V_f(Y(t); n)} = \frac{OM_f(Y(t), y^*, \xi^*; n)}{V_f(Y(t); n)}
\]

Similarly define returns to rival firms $R_{f,R}$
Proposition

At merger threshold

\[ R_{f,M} (y^*; n) = \frac{2 \frac{\Pi_M^a (n - 1)}{\Pi_f (n)} - \Pi_l (n) - \Pi_s (n)}{X_f \frac{X_s + X_l}{X_s}} \]

\[ R_{f,R} (y^*; n) = \left[ 1 - \frac{b^2}{\Delta (n)} \left( 1 + \frac{2}{2 + 3bk} \right) \right]^{-2} - 1, \]

Determined by an anticompetitive effect, a size effect, and a hysteresis effect

Returns to merging and rival firms increase with industry concentration
Figure 2. Cumulative merger returns.

This figure depicts the cumulative returns of a small merging firm (dotted line), a large merging firm (dashed line), and a rival firm (solid line) as a function of the price sensitivity of demand $b$ and the number of large firms $n$. Parameter values are $a = 100$, $b = 0.5$, $K = 1$, $k = 0.2$, $n = 2$, $r = 8\%$, $X_l = 2$, $X_* = 2$, $\mu = 1\%$, and $\sigma = 20\%$. 
Merger with multiple bidders

- A large firm bidder and a small firm bidder compete for a small firm target (Assumption 2)
- Perfect and complete information
- Two bidders submit bids in the form of ownership share
- The bidder who offers the highest value to the target shareholders wins the contest
- Given the winner’s ownership share, the winning bidder and the target select merger timing independently
- In equilibrium they must agree
The large bidder has a production cost advantage, but a merger cost disadvantage.

With similar merger costs, it can always win by copying the small bidder’s strategy.

When relative merger costs are high enough, the large bidder loses the contest.

We focus on the more interesting case where large firm bidder wins.
The small firm may threaten to bid aggressively at breakeven share

\[ \xi_s^{BE} V_l (y; n + 1) - V_s (y; n) - X_s = 0, \]

This threat may be empty

\[ (1 - \xi_i^*) V_M^a (y; n - 1) > \left( 1 - \xi_s^{BE} \right) V_l (y; n + 1), \]

In this case, bidder competition does not matter

Or may be fulfilled

\[ (1 - \xi_i^*) V_M^a (y; n - 1) < \left( 1 - \xi_s^{BE} \right) V_l (y; n + 1). \]

In this case, large bidder pays a premium to deter small bidder
In the last case, the large firm bidder will place a bid $\xi_l^{\text{max}}$ such that
\[
(1 - \xi_l^{\text{max}}) V_M^a(y; n - 1) = \left(1 - \xi_s^{\text{BE}}\right) V_I(y; n + 1).
\]

Define bid premium
\[
\frac{[(1 - \xi_l^{\text{max}}) V_M^a(y_{cl}^*; n - 1) - (1 - \xi_l^*) V_M^a(y_{cl}^*; n - 1)]}{(1 - \xi_l^*) V_M^a(y_{cl}^*; n - 1)} = \frac{\xi_l^* - \xi_l^{\text{max}}}{1 - \xi_l^*} > 0.
\]
Determination of equilibrium

- Industry’s demand shock: \( Y(t) \) is the model’s state variable
Figure 3. Bidder competition and industry competition.

The figure presents the bid premium $(\xi_i^* - \xi_i^{\max}) / (1 - \xi_i^*)$ as a function of the number of large firms $n$ and the price sensitivity of demand $b$. Parameter values are $a = 100$, $b = 0.4$, $K = 1$, $k = 0.2$, $n = 4$, $r = 8\%$, $X_I = 20$, $X_s = 1$, $\mu = 1\%$, and $\sigma = 20\%$. 
Main results: single bidder

- The likelihood of mergers is greater for industries that are more exposed to industry shocks or for more concentrated industries.
- Increased product market competition delays the timing of mergers.
- Cumulative merger returns to merging and rival firms are positively associated with industry concentration.
Main results: multiple bidders

- When merger costs are similar, the large firm wins takeover contest, when competing with a small firm for a small firm target.
- If the industry is sufficiently concentrated, then bidder competition speeds up the takeover process and induces the large firm bidder to pay a bid premium.
- In addition, the bid premium increases with industry concentration.

Dirk Hackbarth, Jianjun Miao
The Timing and Returns of Mergers and Acquisitions in Oligopolistic Industries